



Manufacturing Sciences Corporation

Decontamination and Conversion of Nickel Radioactive Scrap Metal

Technology Need:

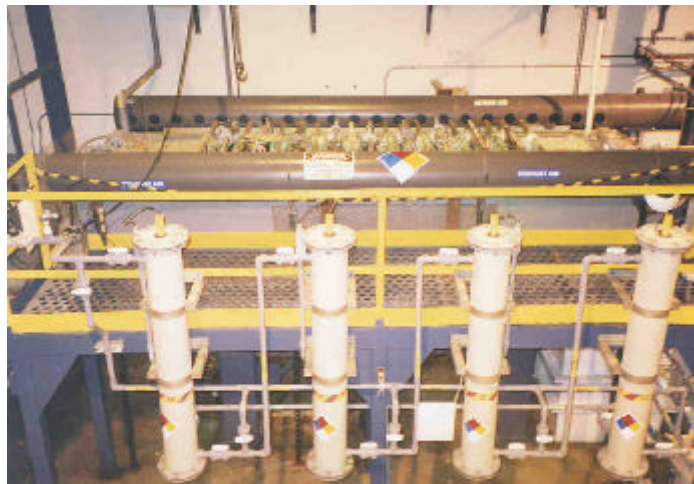
The deactivation and decommissioning of Department of Energy (DOE) facilities will generate vast quantities of radioactive scrap metal (RSM) from process equipment, utilities, and structures. Nickel makes up about 19 percent of the total expected scrap volume but may carry more than 84 percent of the total value based upon current scrap prices. The nickel has been in intimate contact with uranium compounds and is also contaminated with fission products including technetium-99 (^{99}Tc) and trace amounts of neptunium, plutonium, and americium. The contamination cannot be completely removed by surface decontamination methods.

Existing purification technologies such as melt refining and conventional electrorefining have not been able to remove ^{99}Tc to acceptable levels. Cost-effective technologies are needed to remove or reduce the contamination in order to permit recycle or reuse of this valuable resource.

Technology Description:

Manufacturing Sciences Corporation (MSC) has developed an electrorefining process that is capable of removing radioactive contaminants from nickel. This process has demonstrated its effectiveness by reducing volumetric contamination to levels less than 1 Becquerel per gram (Beq/g).

MSC's unique electrorefining process utilizes an electrorefining cell in which a permeable, ion-selective membrane is positioned between the anodes and the cathodes. In MSC's process, contaminated nickel is dissolved electrolytically (as an anode) in sulfate-based electrolyte. Nickel cations (Ni^{2+}), driven by electrokinetic forces, migrate toward the negatively charged cathode.



Top View of Electrorefining Cell

The permeable membrane allows nickel ions to pass through, but prevents ^{99}Tc contamination from reaching the cathode. Purified nickel is deposited or "plated" on the cathode in its metallic state. ^{99}Tc contamination is removed from the electrolyte by recirculating the electrolyte through a filtration/cementation process. The system is capable of semi-continuous operation and is stopped only to remove and replace anodes and cathodes.

Benefits:

- <Specifically targets contaminated nickel that was used as a barrier material in gaseous diffusion plants
- <Capable of removing ^{99}Tc to below 1 Becquerel per gram (Beq/g)
- <Economical recovery of a valuable national resource
- <Decontamination and recycle to useful new products
- <Elimination of an environmental liability
- <Application to recycle of metals of all types

Status and Accomplishments:

This project was completed in April, 2000. After successful lab-scale and pilot-scale demonstration in Phases I and II, MSC demonstrated a full-scale electrorefining system for the removal of ^{99}Tc from diffusion plant nickel in Phase III of this project. The primary components of the demonstration system were a 2,000 gallon main tank, 10 anodes, 11 cathodes, each approximately with approximately 20 square feet of surface area. The full-scale system was designed to process 160 pounds per day of contaminated nickel.

Contaminated nickel ingots from Paducah were utilized to demonstrate the process. This nickel had been previously melted during the Cascade Improvement Program/Cascade Upgrade Program (CIP/CUP) from the late 1970's early 1980's. These nickel ingots were sliced into anode sheets, mounted on hangers and placed directly into the electrorefining cell. The initial ^{99}Tc contamination in the ingots ranged from 226 to 627 Bq/g. The demonstration was conducted at MSC's facilities in Oak Ridge, Tennessee.

Phase III also included an evaluation of electro-refining alternatives including direct dissolution, melting of nickel into anodes, a laser cutting demonstration, an investigation of commercial markets for radioactively contaminated scrap metals, and refinement of methods to conduct quantitative isotopic analyses.

In August of 1997, DOE awarded a fixed price contract worth \$238 million to British Nuclear Fuels, Limited, Inc. (BNFL), to decontaminate three buildings at the former K-25 site, now called East Tennessee Technology Park (ETTP). As part of the agreement, BNFL will take ownership of the scrap metal at a credit back to DOE of over \$55 million. In this contract, MSC, a BNFL Inc. company, will decontaminate nickel and other metals. The electrorefining technology developed under this contract will be deployed to decontaminate 6,000 tons of nickel alone along with other metals.

On January 12, 2000, former Secretary of Energy Bill Richardson placed a moratorium on the free release of any "volumetrically" contaminated material into general commerce from department facilities. Later on July 13, 2000, Richardson expanded the scope of the moratorium to include all radioactively contaminated scrap metal. This decision was made give the Nuclear Regulatory Commission time to develop national standards for volumetrically contaminated materials, allow public comment, and review alternatives to free release. This moratorium has indefinitely halted BNFL/MS C's planned sale of recycled nickel from Oak Ridge's K-25 facility at ETTP. The BNFL, Inc. contract was renegotiated as a result of the moratorium.

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Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 234
<http://ost.em.doe.gov/tms>

The National Energy Technology Laboratory Internet address is <http://www.netl.doe.gov>

For additional information, please visit the Manufacturing Sciences Corporation Internet website at <http://www.mfgsci.com/mainfram.html>

The Innovative Technology Summary Report (ITSR) for Decontamination and Conversion of Radioactive Scrap Metal can be viewed at: <http://apps.em.doe.gov/ost/pubs/itsrs/itsr234.pdf>